Caspian Journal of Environmental Sciences

Online ISSN: 1735-3866
Print ISSN: 1735-3033

The role of community forestry in catastrophic recovery: A case of reconstruction in post-earthquake in Gorkha district, Nepal

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ABSTRACT

Nepal was hit by a mega earthquake and subsequent aftershocks in 2015, which severely affected the rural lives. The contribution of community forests to recover from the aftermath of earthquake is least studied. On this purview, this study aims to examine the roles of community forestry to recover from earthquake's impact, through an analysis of the use of forest products for the daily use, reconstruction of houses and infrastructures. Based on 185 households, and 11 key informant interview contribution of forest was assessed. Initially, forest products use pattern decreased immediately right after the earthquake in 2015 and it subsequently increased in the year 2016 and 2017. In 2015, earthquake year, the timber consumption was very less but the fuelwood and fodder demand were fulfilled through private lands and others. Timber and fuelwood harvest from community forest in 2017 was higher than before 2015. However, the temporary reformulation form government for allowing to harvest up to 90% of annual increment of the community forests helps to meet the demands and remains under the sustainable limit. Despite having different forest resources, community forests are the first choice to fulfill daily needs. Thus, comparatively community forestry has the ability to contribute more to post-disaster restoration and recovery period than the other forest resources.

Keywords: Forest products, Post-earthquake recovery, Consumption pattern, Rural development, Sustainability.
Article type: Research Article.

INTRODUCTION

Nepal is asmall country rich in biological diversity along with climatic and geographic variations. Here, mountains are young and fragile and comprise of rugged terrains, hence diverse ecosystems are in threats. The fact that Nepal is ranked fourth and eleventh in the world for climate change and earthquake risk respectively, demonstrates how susceptible Nepal (MoHA 2018). Ability to cope with sudden economic shocks and natural disasters is likely to be limited. Low gross domestic product (GDP), which leads to poor economic growth and widespread corruption, has kept the country's Human Development Index (HDI) at 0.57 for 2018, placing it in 147th out of 189 countries (UNDP 2019). Nepal is an agrarian country, with the bulk of the population relying on agriculture and the forest for fuelwood for cooking and heating, feed for livestock, leaf litter for composting manure, and lumber for building houses and animal enclosures. Conversion of forest areas to other land uses has become a severe concern, exacerbated by rapid population expansion and natural disasters such as earthquakes. Forests are also being encroached upon for illegal settlements by non-landowners for political reasons (MoFSC 2017). Because Nepal is placed between two tectonically active plates, the Eurasian and Indian plates, earthquakes are more likely (NPC 2015b). Even though 80% of Nepalese households (HHs) live in the hills, about 64% of HHs rely on forest resources for daily needs (CBS 2011). Forest products such as timber, fodder, fuel-woods, and herbs are consumed

Caspian Journal of Environmental Sciences, Vol. 20 No. 2 pp. 323-336 Received: Oct. 12, 2021 Revised: Dec. 08, 2021 Accepted: Feb. 26, 2022
DOI: 10.22124/CJES.2022.5565

Publisher: University of Guilan, Iran

more frequently, accounting for 20% or more of total household income (Chhetri *et al.* 2015). Community forests[1] have played an important role in satisfying the forest resource demands of rural communities (Adhikari 2005). These have made a significant contribution to improving the local communities livelihoods (Acharya 2002; Springate-Baginski 2003), and promoting forest conservation and regeneration (Gautam *et al.* 2004; Baral *et al.* 2019). On 25th April 2015, Nepal was hit by an earthquake of 7.8 Richter magnitude the epicenter being the Barpak village of Gorkha district, that lasted for approximately 50 seconds (USGS 2015). Subsequently, second major shock was felt on May 12, 2015 which was 7.3 Richter scale magnitudes. Nepal's Ministry of Home Affairs reported the deaths of 8,790 people and the injuries of over 22,300 others, as well as the destruction of nearly half a million homes and other infrastructure, displacing hundreds of thousands of people. About one-third of Nepal's total gross domestic product was lost as a result of the catastrophe (NPC 2015a). The National Planning Commission (NPC) of Nepal conducted a Post Disaster Need Assessment (PDNA) study, which found that the earthquake caused loss and damage in various sectors such as infrastructures, agriculture, tourism, and the environment, among which environment and forestry were identified as cross-cutting sectors impacted by the earthquake (NPC, 2015c). People from different communities have a different living standard, disasters affect those communities in different ways, depending on their level of household economy. Exposure to disaster vulnerability is determined by the HHs economy from agricultural income, types of membership, and total revenue (Bista 2018). People who live on a subsistence level in rural areas are the most vulnerable (Cutter *et al.* 2003). Adoption of a livelihood strategy after a disaster is determined by the socioeconomic status of each household in their community (Wei *et al.* 2019). In this example, small-scale farmers in the mid-hills who lived near the epicenters of the 2015 earthquake were severely impacted, resulting in the loss of life, property, and infrastructure (NPC 2015b). Following the earthquake, there was an increase in demand for timber and other forest products for reconstruction (NPC, 2015c). Around 27 billion can be generated from community forest alone, however, which is currently way below to the optimum harvestable amount (Paudel *et al.* 2014). It is difficult to meet the demand for forest resources for reconstruction purposes for large groups of people at the same time. Extraction of wood from natural forests is a difficult operation due to legal binding of the government. Furthermore, Nepal continuously suffers from poor governance, lesser favorable rules, and regulations, delay in timely revising of existing forest policies to handle the emergency, bureaucratic discretions and conservation-centric approach to addressing timber demand and supply imbalances (Dhungana & Bhattarai 2008; Banjade 2012; Paudel *et al.* 2014). Moreover, the government issued circulars and decree to restrict green tree harvesting in 2011, and provision of national average growing stock volume of 178 $m^3 ha^{-1}$ has restricted the timber harvest (Baral *et al.* 2018). Besides, in 2015, the Government of Nepal issued Community Forest Product Collection and Sale Directive 2015 (MoFSC 2015), which further strengthened the role of forest bureaucracy in curbing timber harvesting. To meet this timber need, temporary adjustments to existing restrictions were required to meet future expectations. (Paudel *et al.* 2015). Approximately, Nepal has about 45% of its total area, but unable to utilize the available resources due to difficult terrains (DFRS 2015). Over one third of the forest patches has already been handover as a community forest to the local communities for the sake of conservation and use. For the last four decades, community forestry has influenced community development (Chhetri *et al*. 2012; Bhandari *et al.* 2019), and has been a paralleled partner to support the human beings socially, economically and naturally. Despite having rich in forest areas, Nepal still imports around NRS 6 billion worth of tibmer by each year (The Rising Nepal 2019). This is unfair because forest technocrats are apprehensive about allowing tree harvesting and enforcing necessary norms and rules (Baral & Vacik 2018). Local communities are given the opportunity to manage and use forest resources in accordance with government directions through community forestry. To comprehend rural recovery from a difficult circumstance, one must first comprehend the realities of local life, as well as the geographical location, social, and economic aspects (Cradock-Henry *et al.* 2018). Community forest are the first priority to have access and often get timber at subsidized prices for constructing their houses and sheds (Pokharel 2008). Hence, the need of forest products especially timber becomes more evident in cases of catastrophes, making community forests the first obvious choice for reconstruction and recovery. Above all, understanding whether forests are able to meet the upsurge demand of forest resources (timber, fuelwood and fodder) in post-earthquake period has become vital. Though there are several studies on the sustainable use and management of community forests in rural livelihoods (Meilby *et al.* 2014; Pokharel *et al.* 2015). The study on the use of forest resources is

[1] Forest Act 2019, defines community forestry as the national forest handed over to the forest user groups pursuant to section 18 for the development, protection and utilization of common interest in the interest of community.

lesser during a recovery period from 2015 earthquake needs attention. Our research intends to quantitatively examine whether the forest resources was enough for reconstruction? What were the major contributing sources of forest resources to build back? This study attempts to explore how local households in the mid-hills benefited from the community forests during the post-earthquake recovery period.Additionally, it digs the following specific objectives Quantify, at the household level, the amount of forest resources consumed from the different forest sources. Pre-Post earthquake consumption pattern of forest resources by the community forest users Comparison of the forest's resources use pattern with the annual allowable cut limit for the respective community forests.

MATERIALS AND METHODS

Study Area

The study was conducted in Gorkha district, Nepal (84°25'7.87"E - 85°11'52.86"E to 28°45'7.97"N - 27°47'44.18"N ° E), population 271,061 (CBS, 2011). It is a mountainous district where most of the people depend upon agriculture, livestock farming, and foreign employment (Indian Army, UK Army). It is one of the 14 districts "severely hit" by 2015 earthquake having an epicenter on 25th April (Tachibana *et al.* 2019; Fig. 1). Simjung Village Development Committee (VDC)[2] was selected for the study which was severely affected and front-facing region of 2015 earthquake epicenter at Barpak VDC (Table 1). Simjung VDC was chosen because it was necessary to assess the situation on information regarding the forest resources consumption pattern that how the adjacent communities are thriving and fulfilling their daily demands.

Table 1. Characteristics of study area.

Site name	Details
District	Gorkha
Physiographic Regions	Middle Mountain
Elevation (meter above sea level)	300 to 8156 m
Main Livelihood activities	Paddy, Millet, Maize, non-farm employment, Livestock Farming
Dominant forest types	*Schima walichii, Castanopsis indica, Shorea Robusta, Pinus roxburghii*
Total area (Hectare)	361000
Private Trees on agricultural land	Yes

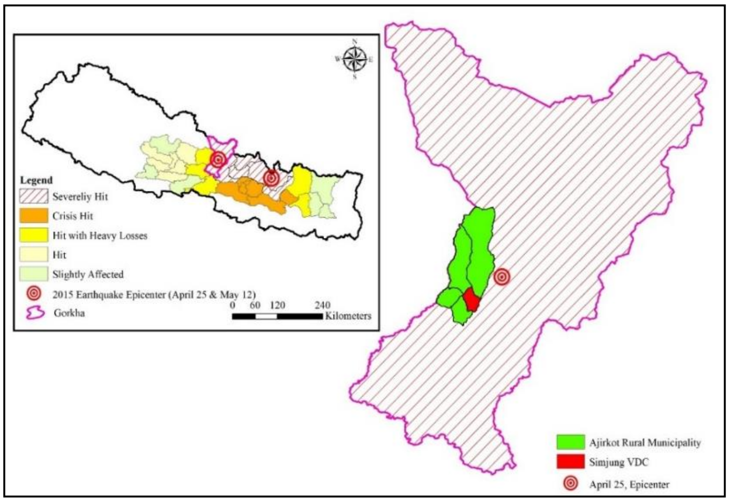

Fig. 1. Map of Study Area, showing earthquake epicenter, an earthquake hit districts, Rural municipality, VDC.

Simjung VDC covers an area of 1344.77 hectares in total, having a total population of 3,715 and only 841 households with mixed ethnicity, where the dominant population is Janajatis (*Gurung*, *Tamang* and *Ghale*; CBS, 2011). To date, 13 community forest user groups (CFUGs) are formed, the community forests are dominated by Sal, *Shorea robusta*, Chilaune, *Schima walichii*, Katus, *Castonopsis indica* and Khote Salla *Pinus roxburghii* depending on the aspect and altitude of the forest. There exists variation on the forest conditions and material benefit that can be obtained from forest, hence there is difference between the growing stocking volume and

[2] After the federalism in Nepal political boundary has been changed i.e., multiple VDCs are merged to a single Rural Municipalities, (In this study, study area Simjung VDC falls under Ajirkot Rural Municipality)

annual allowable harvest from the community forests (Table 2). All the different types of the forest come under the authority of Barpak Illaka of District Forest Office, Gorkha (DFO, 2017). The Majority of the houses are made by mud-bonded and constructed of bricks or stone. Firewood is the significant sources of fuel energy for cooking purposes. Majority consume forests products from community forests to meet their daily demands (CBS, 2011). In total the study area comprises of 13 CFUGs covering an area of 354.78 hectares (Table 2). However, membership duplication is a common issue in the VDC. Being a multiple user of CFUGs is common because of limited availability of most preferred timber species called Sal. It is not common in all community forests and people want to have membership in community forest having Sal dominant. In the study area, *Shorea robusta*, *Schima wallichhi*, *Castonopsis indica*, *Pinus roxburghii*, *Alnus nepalensis* are the common species found. The average growing stock volume 13 community forests according to the approved Community Forest operational plan was 103.58 $m^3 ha^{-1}$.

Table 2. Characteristics of community forest; Growing Stock [Source: District Forest Office, Gorkha (DFO, 2017)].

Name Community Forest	Handover Year	HHs	Area (ha)	Annual Growing Stock (m^3ha^{-1})	Forest Types	Dominant Species
Aarubote	2057	81	7.32	114.5	Sub-tropical mixed forest	*Schima-Castanopsis*
Mausuli Pakha	2054	52	45.55	156	Sub-tropical broad-leaved forest	*Shorea robusta*
Himali Laligurans	2061	148	53.50	80	Sub-tropical mixed forest	*Pinus roxburghii, Rhododendron arboreum*
Dhovan Pakha	2057	72	46.02	126.62	Sub-tropical mixed forest	*Schima-Castanopsis*
Saune Chuiribote	2052	153	22.81	102.57	Sub-tropical mixed forest	*Schima-Castanopsis*
Nimare Pakho Mahila	2056	53	5.34	62.85	Sub-tropical mixed forest	*Schima-Castanopsis*
Dhoke Dhunga Darbare Pakha	2061	259	36.18	66.18	Sub-tropical mixed forest	*Schima-Castanopsis,*
Pokharetar Paharepani	2054	83	39.95	108.8	Sub-tropical broad-leaved forest	*Shorea robusta*
Jhankrepakha	2049	137	16.07	159.57	Sub-tropical broad-leaved forest	*Shorea robusta*
Amale Mandir Danda Bhirkuna	2056	106	12.06	104.14	Sub-tropical mixed forest	*Schima-Castanopsis*
Darbote Kathe Danda	2049	88	12	106.02	Sub-tropical mixed forest	*Schima-Castanopsis*
Didi Bahini Mahila	2051	123	3.85	36.8	Sub-tropical mixed forest	*Alnus nepalensis*
Simjungkot Salghari	2065	468	54.13	122.6	Sub-tropical broad-leaved forest	*Shorea robusta*
Total		1823	354.78	Avg=103.58		

Note: The majority of the households are members of at least two community forests, and some are even in three. However, the total population was considered 841 based on National Census, 2011 (CBS, 2011).

Data collection

Household survey has been carried out for the data collection from March to May of 2018. At First, a consultation meeting was conducted before the survey with the primary advisor, co-advisor, and other professors at Institute of Forestry, Pokhara to discuss the objectives, limitations, and study method and then designed a questionnaire for effective results. Three principal instruments were used for the data collection, household interview, focus group discussion, and key informant interview. For household interview sampling was done in such a way that covering each ethnic group using random selection, in which at least 10 HHs from a CFUGs having less than 100 HHs beneficiaries and 10% of the total HHs from in each community forests having more than 100 HHs beneficiaries. Overall, the total sampled HH (N = 185) was 22% of Simjung VDC HHs (N = 841). During survey, household head was preferred for interview. Major areas of inquiry included the economic status, social status of the household, and the requirement and consumption of forest products before (2014) and after the earthquake (2015). Since no data were available for previous year, therefore "*Memory Recall Method*" (Giri *et al.* 2018; Richards *et al.* 2003) was used. It is the best approach available, and because 2014 was not far away, people could easily recollect the utilization of forest products (Baral *et al.* 2019). Under this method HHs level information on forest resources (fuel-wood, fodder, and timber) consumption from 2014 to 2017. Similarly, key informant interview (N = 11) was done with some key members of the community which includes social worker, ward & executive members of FUGs representatives, women group, informal group, political leaders and school teachers. The key informants were interviewed to dig detailed information on how the forest has contributed to the situation during a disaster, recovery, and the reconstruction period, including critical issues faced in collecting forest products from the community forests. Furthermore, various available documents and literature from local and governmental levels were reviewed to gain insights into people's dependency on forest products during the disaster and in the recovery process too. Besides, analysis of emergency reformed rules, circulars, and decree issued by the Department of Forests (DoF) and the activities carried out in community forests by the user groups was done. The study of each community forest's operational plans, past yearly minutes, enables us to view the research query in an interdisciplinary manner and also simplified the way of dealing with respondents.

Data analysis

From the fieldwork during the survey period from March to May 2018, both qualitative and quantitative data are collected, where from qualitative data narrative story was developed by interviews, household surveys, and observation in the field. The obtained data was triangulated by interviewing the district level stakeholders such as Division Forest Officer, Sub-division Forest Officer and other staff at Division Forest Office. Similarly, quantitative data were analyzed using frequency, percentile, mean and median. The annual average was calculated, and the trend lines are prepared from 2014 to 2017. In the same way, average HH timber and fuelwood consumption from community forest was compared with the general average annual allowable cut (AAC[3]) as well as revised temporary annual allowable cut of all 13 community forest at once. Annual allowable cut (AAC) at two different levels of harvesting of the allocated annual increment, i.e., at 50% and 90% level. Microsoft Excel was used for analysis and preparation of required diagrams like graphs, tables and trend lines. AAC is completely relies on the annual average increment of the forest. In Nepal, usually DFO allocates from 40 to 50% of total annual increment depending upon species composition and incremental rule as guided by Community Forest Inventory Guideline (DoF 2004). Depending upon the annual average increment the AAC differs for different community forests. But right after the earthquake hit the country, Ministry of Forest and Soil Conservation (MoFSC) reformulate a relief guideline to the CFUGs that according to the local and DFO understanding DFO can allocate AAC up to 100% of annual increment. But, in our study area only up to 90% has been allocated. Therefore, regarding the evidence of maximum allocation for AAC of annual increment before earthquake up to 50% and after earthquake up to 90% was compared. The fodder consumption has not been compared with the AAC because lack of information on fodder allocated thresholds.

RESULTS

Sample Characteristics

Out of a total 841 households of Simjung VDC, only 185 of them were interviewed. Table 3 presents descriptive statistics of the 185 sample HHs. Among the 185 respondents, 57.84% of them were between the age of 50-69 years, followed by 27.02% above 70 years and 15.14% between 24-29 years. The study sample was composed of mixed ethnicity dominated by Janajati (49.19%), followed by Dalit (27.57%) and Brahmin/Chhetri (23.24%). Majority of the respondents (60.54%) were engaged into the agriculture profession, followed by unskilled daily wage (15.14%), pension/job/services (8.11%), small scale business (6.49%), skilled wage work (5.40%) and home responsibilities (4.32%). Average livestock holdings status per HH was 2.61 LSU (Livestock Unit) just before the earthquake year. After the earthquake and aftershocks in 2015, much of the property was damaged along with the deaths of the livestock holding, which reduced to 1.83 LSU and in 2016 remains stable. Regardless, in the year 2017, little bit livestock holdings per HH have increased but not like before up to the level of 1.97 LSU per HH.

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[3] The annual allowable cut refers to the annual amount of timber that can be harvested from a patch of forest area in a sustainable basis.

This study concluded a remarkable number of livestock loss within the study area, with a value of 0.35 LSU per HH.

Table 3. HHs Characteristics of sampled (n = 185) households.

Parameters	Characteristics	No. (%)	Mean
Basic information	(Average household size)		6
	The average age of household members		43
Caste/Ethnic Composition	Janajati	91 (49.9)	
	Dalit	51 (27.57)	
	Brahmin/Chhetri	43 (23.24)	
Land holding	Irrigated Farmland		5.27
	Non-Irrigated Farmland (Ropani[a])		4.71
Livestock	Livestock Unit (LSU) own per HH		2.06
	Livestock Unit (LSU[b]) loss per HH		0.35
Damage from earthquake	Damage to House: Need at least		
	Structural Repair	23 (10.27)	
	Reconstruction	166 (89.73)	
Profession	Agriculture	112 (60.54)	
	Unskilled Job	28 (15.13)	
	Skilled Job	10 (5.41)	
	Pension	15 (8.11)	
	Business	12 (6.49)	
	Home Responsibilities	8 (4.32)	

[a] Ropani is the unit of land area in Nepal: 1 Ropani = 508.74 m^2

[b] LSU Conversion factor adopted from FAO (FAO, 2005)

Timber consumption

On analyzing the timber consumption pattern in Simjung VDC, we found the annual average timber consumption per HH per year was less before, which increased after the earthquake (Fig. 2). The focus group discussion revealed that the local villagers identified five different sources of timber for reconstruction. However, on analyzing their dependency, community forests yielded the highest amount of timber followed by timber from old/damaged houses, private land, and purchasing from the market. The government managed forest, though identified as a source of timber; it did not contribute to the recovery process. It happens because of not easy access.

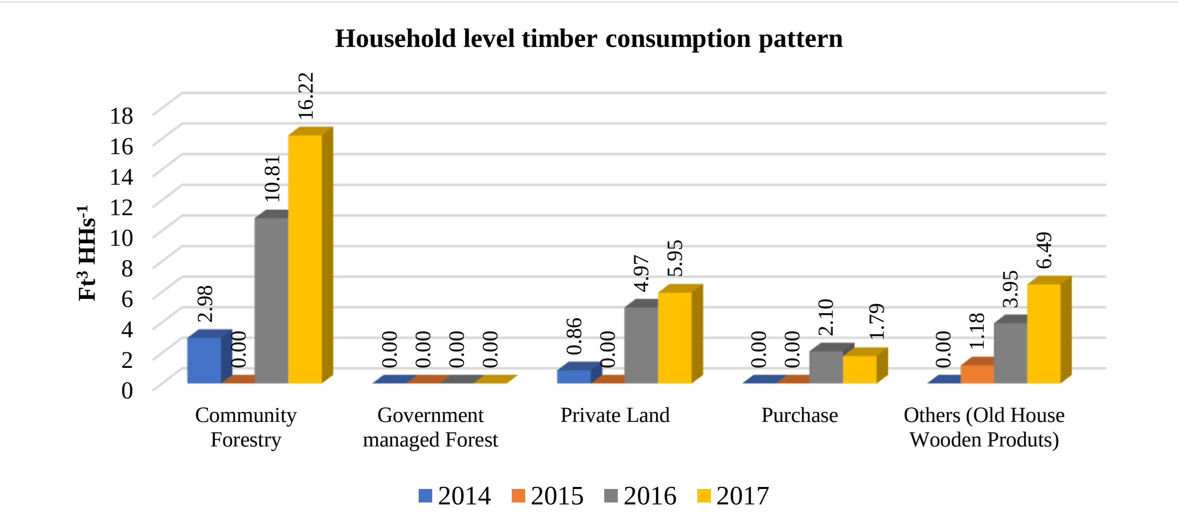

Fig. 2. Timber Consumption per Households.

Before the 2015 earthquake, in 2014, the average timber consumption from community forest and private land were less with value 2.98 $ft^3 HH^{-1}$ and 0.86 $ft^3 HH^{-1}$ per year, respectively. However, immediately after the "severe hit" of an earthquake majority of people become homeless, started to stay in temporary shelter, only the timber from damaged houses was used, and no timber was consumed from community forests, private land, and some people even purchased timber for constructing their house. Because even passing through harsh condition CFUG executive committee circulated a notice to the users and restricted the users to enter the forest. If anybody would enter without permission, it would be considered as an illegal harvesting. But at that particular point of time, people were also looking for the relief package from the government in terms of financial and natural resources consumption. Only 1.18 ft^3 HH^{-1} per year (excluding bamboo) was used as source from wrecked woods to construct a temporary shelter which was only a nominal amount of timber for such construction work. In the first year, the fear of aftershocks and lack of support from the government for reconstruction and renovation discouraged the people from constructing new houses. So, in the first year, people used wretched wooden products from their wrecked houses, and bamboos were used to build temporary shelters. The construction/renovation of the houses only started in 2016 when the Government of Nepal (GoN) declared it's safe to go back to normal life like before the earthquake. However, the construction of houses did not accelerate as expected because of continuing aftershocks and lack of financial resources and inadequate grants and subsidies from the government. The National Reconstruction Authority was established in December 2015, which aimed to construct the structures damaged by the devastating earthquake of 2015 in a sustainable, resilient and planned manner to promote national interest and provide social justice by making resettlement and relocation of the persons and families displaced by the earthquake. It then, formulated a mechanism to provide financial support for residential buildings adopting a "house-owner driven approach stating that equal technical assistance and subsidy will be provided to each family without differentiating between who lost what." Initially, National Reconstruction Authority circulated a notice to District Reconstruction Office to enlist the victims and provide Red Card to the households severely hit by the earthquake in 14 districts of Nepal. However, to obtain the subsidy from the government, the house owner needs to open a Bank Account where government would reimburse the amount. The government would provide the financial support to the households reconstructing their houses in three stages of installment according to the progress of HH reconstruction. Initially, government provides NRs fifty thousand rupees then earthquake victims need to construct DPC (Damp Proof Course) and verified with the respective rural municipality engineer to be eligible for the second installment of NRs One lakh rupees only. With this 2nd amount they need to construct house with iron galvanized roof, side wall and again after completing house construction need to verify from respective engineer to be eligible for final installment of NRs One lakh and Fifty thousand rupees only. Earthquake victims receives in total NRs Three lakh rupees (in digit 300,000) only from government which is equivalent of 2941.18 $ (1 USD = 102 NRs). Because of this, there was a sudden rise in timber demands from 0 to 10.81 ft^3 HH^{-1} per year in 2016 and which rose upto 16.22 ft^3 HH^{-1} per year in 2017. Similarly, average timber consumption from private land reached annually to 4.97 ft^3 HH^{-1} in 2016 to 5.95 in 2017. Consumption by purchasing timber from markets observed in 2016 to 2.10 ft^3 HH^{-1} per year and falls to 1.79 per year in 2017. Timber consumption observed from the markets because each people demand varies and demand only Sal species for reconstruction which is very limited (Table 2). So, people having good economy go for markets to fulfill their demands from nearby sawmill and other private land. Furthermore, in parallel to the reconstruction of houses, they have even reused woods from wrecked house to fulfill deficit timber demand and to reduce their expenses in the timber, which value was 3.95 ft^3 HH^{-1} and climbed up to 6.49 per year in 2016 and 2017 respectively.

Fuel-wood consumption

The study results (Fig. 3) showed that the significant sources of fuel-wood consumption by villagers are from community forests, private land, government, managed forests, and others (old house wooden products). Initially, fuelwood estimated in unit bhari[4] as a common local unit for estimation. In 2014, the average fuel-wood consumption per HH per year from community forests was about twice of private land, where community forest with value 843.5 and 409.15 kg HH^{-1} per year for private land. It dramatically reduced to 177.84 from community forests while a slight rise was seen from private land with value 490.35 in 2015. A small amount of firewood was brought from the community forest, people hesitated to enter the forest during the time of earthquakes and its aftershocks. Thus, during this period, the fuelwood which was stocked was used. Gradually, in the following year,

[4] The bhari is a local unit of firewood. One bhari is a bundle of firewood one can carry. Its average weight is 30–35 kg (approximately; Nepal *et al*. 2011)

2016 and 2017, fuelwood consumption from community forests rose up to 441 and 714 kg HH^{-1} per year respectively. However, the firewood from private land steadily fell to 458.41 and 424.90 per year, respectively. The average fuelwood consumption from private property was suddenly rose in 2015 because people were living in groups and sharing the kitchen and the foods and they were not allowed to enter the community forest, which directly uplift the use of firewood from their own land, compared to 2014 before the earthquake. As the year passed on consumption from private land slowly falls down to 424.90 in 2017. Despite the restriction of extraction of forest products from government-managed forests, a small amount of fuelwood is found to be illegally harvested (Fig. 3).

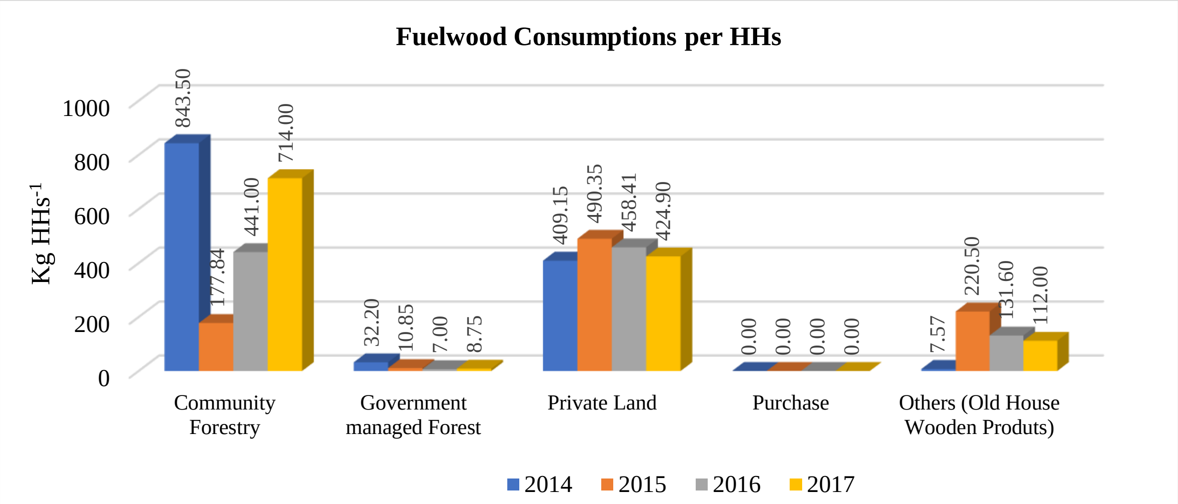

Fig. 3. Fuel-wood Consumption per Households.

Locals also used some highly wretched wood products which may not be useful for timber purpose in future from those wrecked houses and this have played a significant role for their safety and fulfill demands of fuelwood during the earthquake period. Remarkable consumption was seen during the earthquake year 2015 with value 220.50 kg HH^{-1} per year, which decreased by nearly half in the next two years with value 131.60 and 112.00 in 2016 and 2017 respectively.

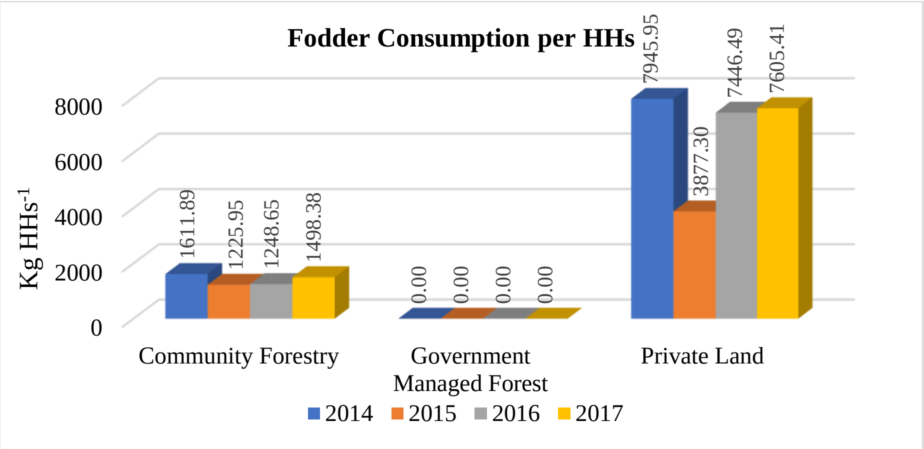

Fig. 4. Fodder Consumption per households.

Fodder Consumption

The fodder was collected mostly from private land, and occasionally from community forests (Fig. 4). For fodder, there was no consumption from government managed forest because nearby/accessible forest is already handed over to the local communities in the form of community forests while remaining government managed forest is inaccessible as it is located far from the villages. The distance from the village keeps the villagers away from government managed forest.

Fodder consumption before earthquake from community forests and private land was 1611.89 and 7945.95 kg HH^{-1} per year in 2014, while during 2015, remarkably decreased to 1225.95 and 3877.30 respectively. As before the earthquake, there was (Table 2) livestock holdings per HH was 2.61 LSU, while 0.35 LSU losses were recorded during the earthquake in 2015. Eventually, it leads to a decrease in fodder demand and then consumption. Additionally, during that hectic period, all of the livestock was left open, and allowed open grazing for their survival. The local people could not take care of the livestock because they have to depend upon the relief materials received. In the following year 2016 and 2017 fodder consumption remains same at 1248.65 and 1498.38 kg HH^{-1} from community forests whereas astonishing rise in use seen from private land in 2016 with the value of 7446.49 and 7605.41 per year from private areas respectively. As per the CFOP the collection of fodder was not allowed throughout the year but only allowed during the annual implementation of silvicultural activities (thinning, punning and other forest management activities), which only for limited period of one to three months.

Timber consumption pattern from community forests

The timber availability was estimated after reviewing the growing stock volume of timber (Table 2) from Community Forest Operational Plan (CFOPs) of the 13 community forests which was prepared based on "Community Forest Inventory Guideline" (DoF 2004). In 2014, the average timber consumption from community forests was 2.98 ft^3 HH^{-1} per year, the year before the earthquake (Fig. 5). There was no consumption during the earthquake year (2015). People were traumatized by the earthquake shock and aftershocks and fear for their lives; they are only looking for survival rather than the reconstruction and other things. Victims went through the entire season (rainy, summer, monsoon, and winter), residing in a temporary shelter built with bamboos and tents. In year 2016, government initiated economic support for the reconstruction of the victim's houses on an installment basis. Right after that, there was a remarkable take off in demand for the timber consumption for reconstruction and renovation by which the value reached 10.81 ft^3 HH^{-1} per year from community forest in 2016. It continues to achieve a higher level at 16.22 in the year 2017. Overall, the four-year timber consumption per HH per year from community forests have been compared with the annual allowable cut (AAC) at two different levels, i.e., 50% and 90% AAC. Consumption in 2016 and 2017 had crossed the limit of AAC at 50% (10.37 ft^3) with a value of 10.81 and 16.22 ft^3. However, both values are under the threshold of average AAC at 90% (18.94 ft^3) as mentioned in the CFOP.

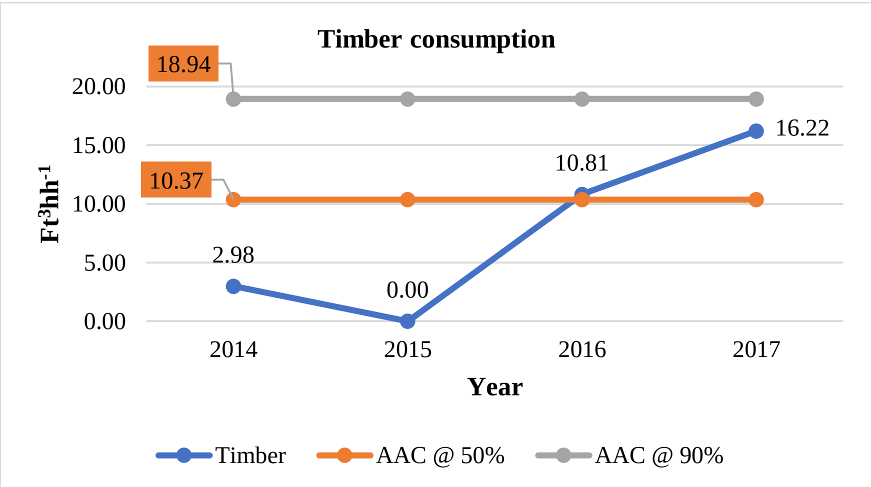

Fig. 5. Timber consumption pattern in community forests and comparing with the general AAC and revised AAC (2014 to 2017).

Fuelwood consumption pattern from community forests

Based on Community Forest Inventory Guideline (DoF 2004), fuel-wood was estimated after reviewing growing stock (Table 2) from CFOPs. From the trend line (Fig. 6) in 2014, the average fuel-wood consumption was 843.50 kg HH^{-1} per year while consumption lowered to 177.84 in 2015 which is because of immediate stop going in the community forest but fulfilling their demands of fuel-wood from the previously stored forest products, private farmland and wrecked house materials (Fig. 3). Similarly, in 2016 and 2017, fuel-wood consumption increased to 413 and 714 kg HH^{-1} per year. All four-year fuel-wood consumption is under both levels of the limit of AAC at 50% (1382.15) and AAC at 90% (2524.20).

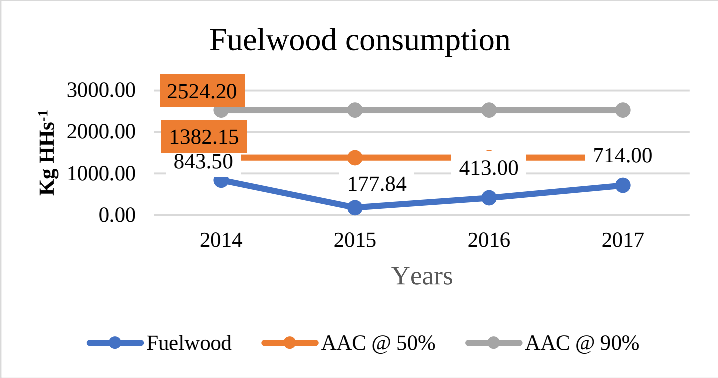

Fig. 6. Fuelwood consumption pattern in community forests and comparing with the general AAC and revised AAC (2014 to 2017).

DISCUSSION

The findings of the paper reveal that the dependency of the people on forest increases after the catastrophes like earthquake. Timber is still a major construction material in Nepalese villages. The study revealed that over these reconstruction periods (2014 - 2017), the average rate of timber, fuel-wood, and fodder consumption per household was less immediately after the earthquake in 2015, which increased tremendously in 2016 and 2017. Community forestry was a major source of timber followed by private forest and reusable woods from the damaged houses. The annual allowable harvest was guiding timber harvest. The special provision made by the government after the earthquake supported to fulfill the timber demand for reconstruction, moreover, people have also started to shift towards *Reinforced Cement Concrete* (RCC) houses instead of traditional Mud-Stone houses and use of galvanized iron roofs and window panels which has also reduced the timber demand. The paper contributed to the understanding of the annual average timber consumption before and after (2014 to 2017) the earthquake in Nepal. The role of timber as a major essential building material is well recognized by the local users as well as the government. The demand for Sal timber is always high, which increased dramatically in post-earthquake reconstruction. To meet the increasing demand from the forest, approximately 33.33 million ft^3 timber is necessary for the reconstruction and renovation of the earthquake affected houses and infrastructures (Paudel *et al*. 2015). Community forests are the major supplier of timber in Nepal. Timber consumption per HH per year revealed that community forests are the primary sources for timber supply for reconstruction and renovation of infrastructures during the post-earthquake compared to private/farmlands and government managed forests. Similar observation was made by (Shrestha *et al.* 2015) in a study in Gorkha district where the government managed forests, community forests and private forests are capable of supplying timber for the reconstruction, while the contribution of the community forests overweighs the other forest management regime. Similarly, we found community forest contributing substantially in fulfilling the timber need of the local people in reconstruction, followed by the contribution from private lands. It is in line with (Bhandari *et al*. 2019) stating that community forestry has always been the first choice of local people as they have easy access to the rural development by providing the forest products needed for their livelihoods. Similarly, most of the people in mid-hills have trees in their private land, which is found as a second important source contributing in the case of disaster and recovery period.

Moreover, the timber yield from the community forests is found to play major role in rural development, the public finance potentiality of community forestry is immense (Bhandari *et al*. 2019; Chhetri *et al*. 2012). Due to an increase in reconstruction and renovation of the infrastructures, it is logical to find that the pattern of timber consumption has increased in 2016 and 2017. This finding resonates with the study conducted by the National Planning Commission of Nepal, where the pattern of timber consumption has increased after the 2015 earthquake and was in increasing trend with the highest use in the year 2017 which is stated as "huge demand of timber in the next year of the earthquake" (NPC 2015c). Fuel-wood is the primary source of energy for cooking foods for humans and livestock in mountain livelihoods (Chettri *et al*. 2002). The primary source of fuel-wood was community forests, which contribute more than twice as the private lands during the normal situation, and this study is supported by (Kandel *et al*. 2016) research on consumption patterns of fuel-wood in rural households. In contrast, during the year of the earthquake (2015), fuel-wood collection from community forest is relatively less, which is compensated by trees on their private lands, storage, and some proportion from those wretched wooden materials squeeze in the damaged houses and cow shades. The consumption of fuel-wood from community forest decreased during the earthquake is a consequence of cooking in the group, untie/free livestock open grazing, which reduces fuel required for daily care and cooking food for human and livestock. As the year passed out, fuel-wood consumption was in increasing trend as people started to come back to their previous location. Fodder consumption from private lands was higher than community forest throughout the period; It is concurrent to (Acharya 2006), which stated that though fuel-wood consumption from private lands is often less than community forests but individual land trees mostly used for fodder. Fodder consumption reduced during the earthquake year and is gradually picking up the pace next year; immediately after an earthquake, people untie their livestock and let them for open grazing to feed themselves. Additionally, livestock losses in earthquake year (2015) were 0.35 LSU per HH, which plays a crucial role in reducing the demand for fodder. However, people are recovering gradually from the earthquake impacts (fear/shocks), and then the locals have started to continue their healthy living way like before so, the consumption of the forest resources can be predicted in returning to the levels of pre-earthquake as shown in Figs. 2-4.

The overall timber consumption from 2014 to 2017 provided evidence of increasing demand of timber for post-earthquake recovery. In our case, the highest amount of timber was extracted in 2017, where the amount extracted exceeded the limit of harvesting 50% of annual increment. Similarly, looking at Forest resources consumption patterns by the local community is within the allowable limit (Shrestha *et al*. 2015), which is in concurrence with this study. As suggested by (Paudel *et al*. 2015), temporary reformulation on the extraction of timber by rising of AAC at 85% of annual increment works to fulfill the demand in a sustainable basis. Regarding the Annual Allowable Cut (AAC) level and the actual harvesting level of timber and fuelwood, their consumption was under the sustainable limit. There was no overharvesting through the community forests because locals are fulfilling their deficit demand, to some extent through private land, neighbors, purchase, and others. The primary reason behind the sustainability was to strictly follow the rules and regulations according to the provision from their CFOPs. Though the Department of Forests had provisioned a transitional system for two years focusing the earthquake whereby community forests were allowed to cut 100% of annual increment for timber and fuel-wood from community forests, however, that was not seen but maintain up to 90% of the increase. According to assumption mentioned on study (Paudel *et al*. 2015; Shrestha *et al*. 2015) requirement of timber from community forest for reconstruction was 50 ft^3 HH^{-1} for wholly destroyed and 30 ft^3 HH^{-1} for partially destroyed private HH being opposite to this statement less than 18.94 ft^3 hh^{-1} from community forest (Fig. 5) was enough for reconstruction. Moreover, timber use from wrecked houses have also useful; additionally, the majority of local people shifted from the traditional old house to RCC/cemented/concrete buildings, use of iron poles, cemented walls rather than mud-tones which reduced the demand of timbers and chance of overharvesting. However, simplification of the timber extraction mechanisms by the government too contributed to restoration and recovery process. Otherwise only harvesting fallen and 4-D (dead, dying, diseased and deformed) would not meet the demand (Paudel et al., 2015). It is supported by the studies which stated that the earthquake provided as an opportunity to "*Build Back Better, Safer and Greener*" (Aryal *et al*. 2019; Hada *et al*. 2016; WWF 2016). According to the study made by Tachibana *et al*. (2019) emphasized the significance improving condition of the forests “Green makes a bold comeback” in two decades. In a study of post-earthquake recovery by Epstein *et al*. (2018) found that the local communal institutions including community forest user groups are effective in immediate and long-term recovery and adaption to the catastrophes. Hence, the significance of forests in the rural livelihoods is found to be even more significant in rural reconstruction after the catastrophes like earthquake and others.

CONCLUSION

The study carried out in Gorkha, one of the most severely hit districts by 2015 mega-earthquake and its aftershocks. This study reveals that the average rate of timber consumption was lower immediately after the earthquake, while firewood consumption was nominal at first and both consumptions progressively climbed over the years. As a mid-hills prime source of energy, fuelwood demand was fulfilled from the private farm lands and old wrecked woods from the damaged house. Despite having the different forest products sources, community forest is found to be one of the most important contributors and only choice for the people in disaster to build back during the process of recovery and renovation. Noteworthy, private land serves as an immediate alternative for the fulfilling the demand of the fuelwood and fodder at emergence. The demand for timber and firewood gradually increased after the 2016 and reach maximum in 2017. Because, the government formally started easy economic facilities for the reconstruction of the damaged houses and infrastructure in the earthquake affected areas. Temporary revision of AAC from the government have played significant role in meeting the demand of timber and fuelwood. The annual consumption of timber and fuelwood are under the allocated AAC limit (i.e., 90% of annual increment) after 2015 earthquake. This implies that there was no illegal felling take place during the earthquake emergence. The findings thereby add to the body of literature on the forest resources consumption pattern and the contributing sources after the devastating incident like the 2015 earthquake and others in future too. Hence, we argue that sustainable consumption of timber and fuelwood from community forests for reconstruction and recovery is necessary in the times of devastations.

ACKNOWLEDGMENTS

We would like to convey our sincere thanks to all the HH of Simjung VDC (current Ajirkot Rural Municipality) who participated in this study, DFO, Gorkha, and Community Forests of Simjung VDC and extend our thanks to Mr. Rabin Paudel, Mr. Datta Basnet and Mr. Pawan Karki for their assistance in data collection. We would also like to thank Ms. Goma Thapa for her continuous encouragement. We gratefully acknowledge the Gorkha Earthquake Project of Science and Power in Participatory Forestry (SCIFOR) at Institute of Forestry, Pokhara, Tribhuvan University, Nepal to support for the field work to conduct this research.

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Bibliographic information of this paper for citing:

Poudel, P, Kunwar, N, Bahadur Rumba, Y, Paudel, R 2022, The role of community forestry in catastrophic recovery: A case of reconstruction in post-earthquake in Gorkha district, Nepal. Caspian Journal of Environmental Sciences, 20: 323-336.